(12) UK Patent Application (19) GB (11) 2 010 095 A

(21) Application No 7847752
(22) Date of filing
8 Dec 1978
(23) Claims filed
8 Dec 1978
(30) Priority data
(31) 2754917
2824118
(32) 9 Dec 1977
1 Jun 1978
(33) Fed Rep of Germany (DE)
(43) Application published
27 Jun 1979
(51) INT CL² A61C 8/00
A61B 3/00
B23C 5/12
(52) Domestic classification
A5R DJ DN
B3K 2A3 2A4G
(56) Documents cited
GB 1423198
GB 1320655
GB 1275536
GB 1203093
GB 770696
DE 2620907A
(58) Field of search
A5R
B3K
(71) Applicant
Guido Riess
Marienplatz 7
D-8100 Garmisch-Partenkirchen
Germany
(72) Inventors
Guido Riess
Helmut Heide
Wolfram Krieger
Kari Koster
(74) Agents
Kilburn & Strode

(54) Dental implant

(57) A dental implant, Fig. 1, has a root in the form of a curved metal plate 1 carrying a connecting portion 5 for mounting a dental superstructure. The plate is coated with a layer 4 of a biostable polymer in which are embedded spheres of reabsorbable tricalcium phosphat partially coated with non-reabsorbable tetracalcium phosphate. The plates has holes 2 in it filled with a reabsorbable calcium phosphate 6.

When in position, the reabsorbable calcium phosphates are r absorbed and replaced by new bon thus anchoring the implant in position.

A milling device, Fig. 9, for shaping a jawbone to receive the above implant, comprises two discs 108,109, each having an edge portion shaped to provide a concave cutting surface 110. Inserts 115 may be provided to adjust the shape of the composite cutting surface.

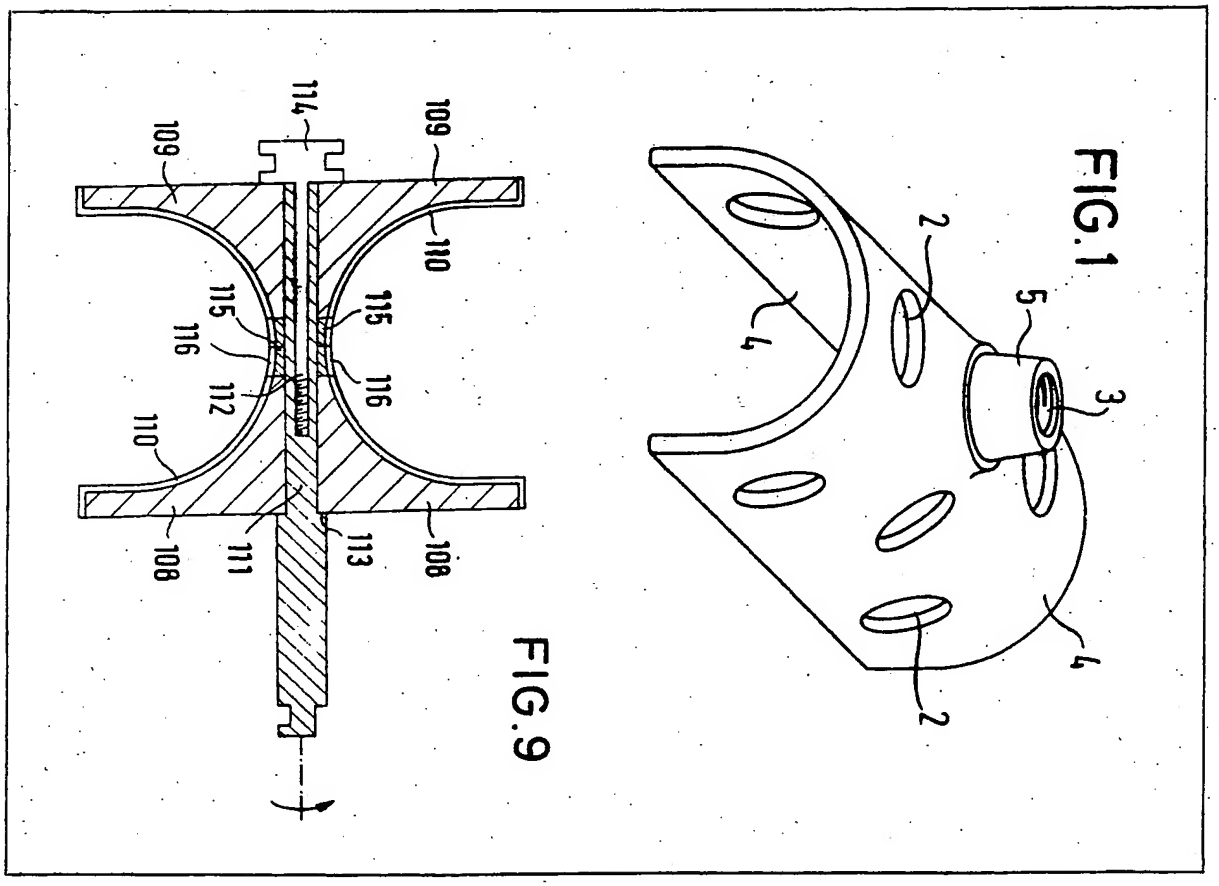


FIG.9

FIG.1

GB 2 010 095A

2010095

FIG.1

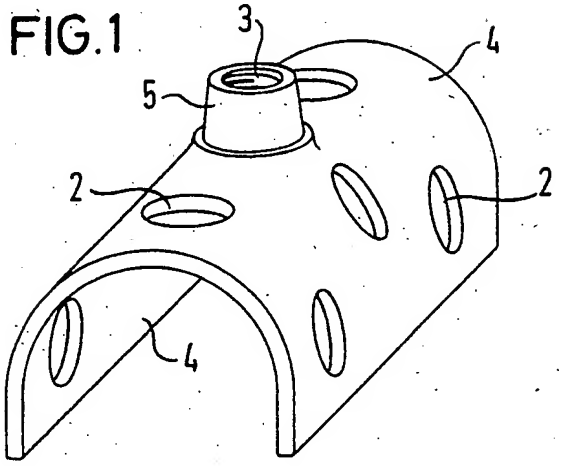


FIG.2

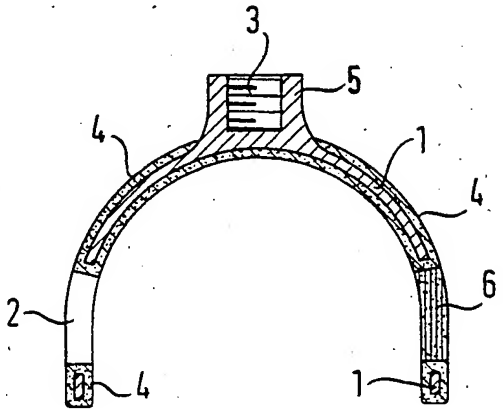


FIG.3

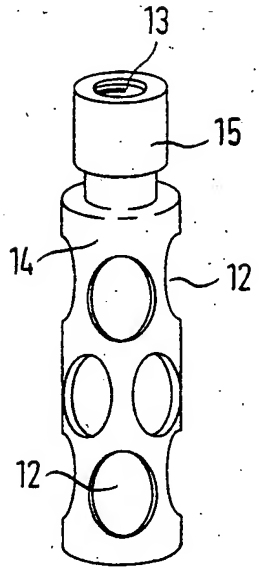


FIG.4

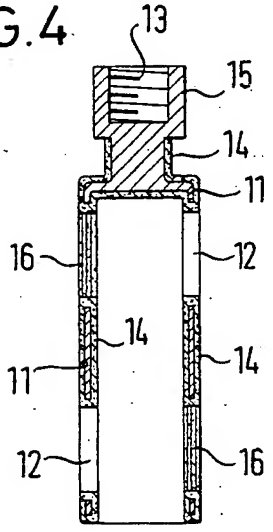


FIG.5

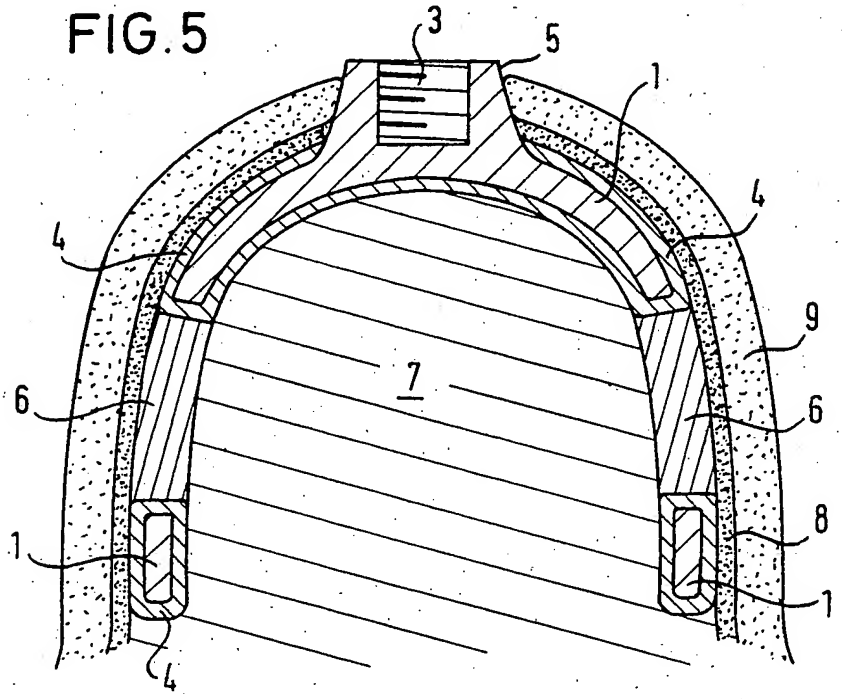


FIG.6

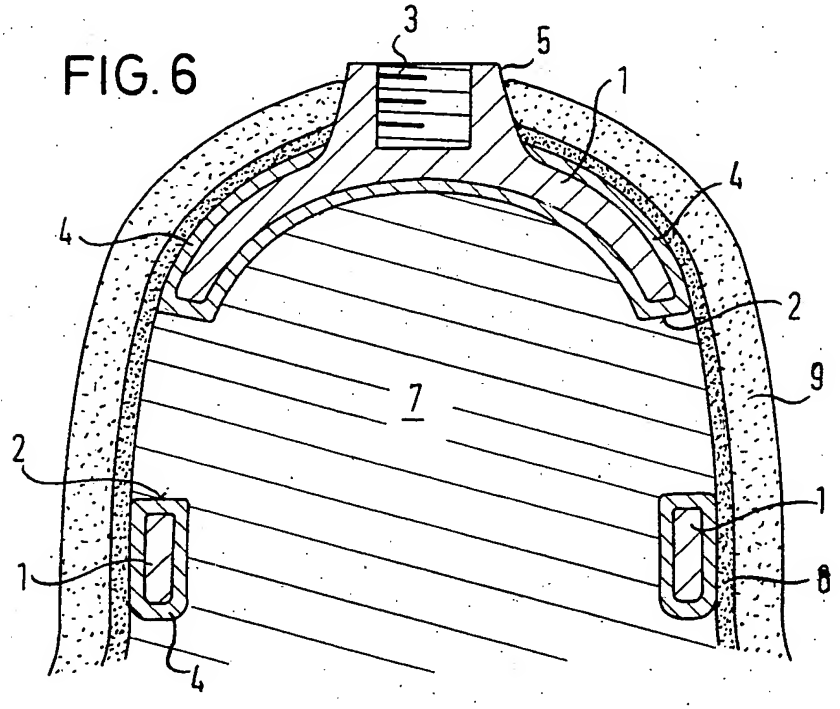


FIG.7

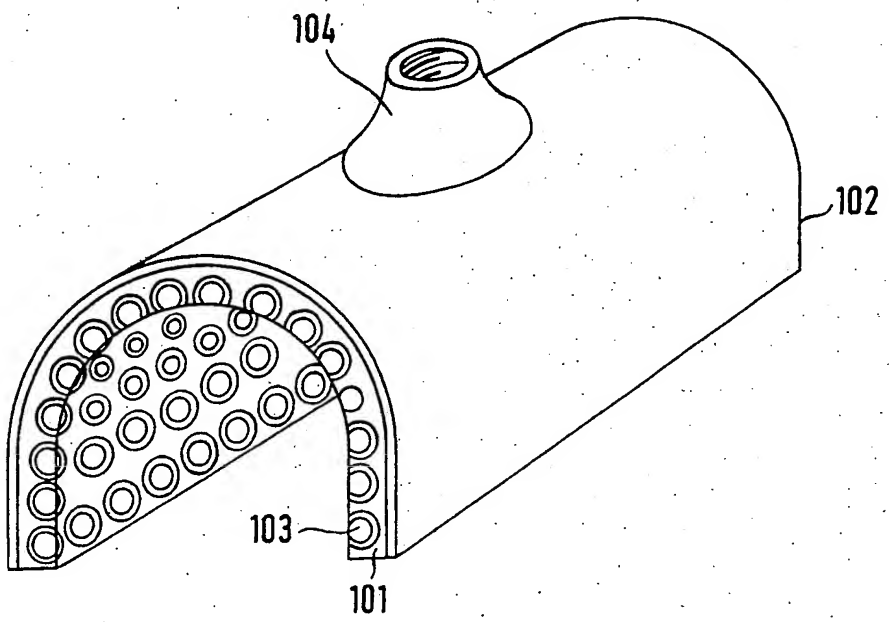

104
102
103
101

FIG.9

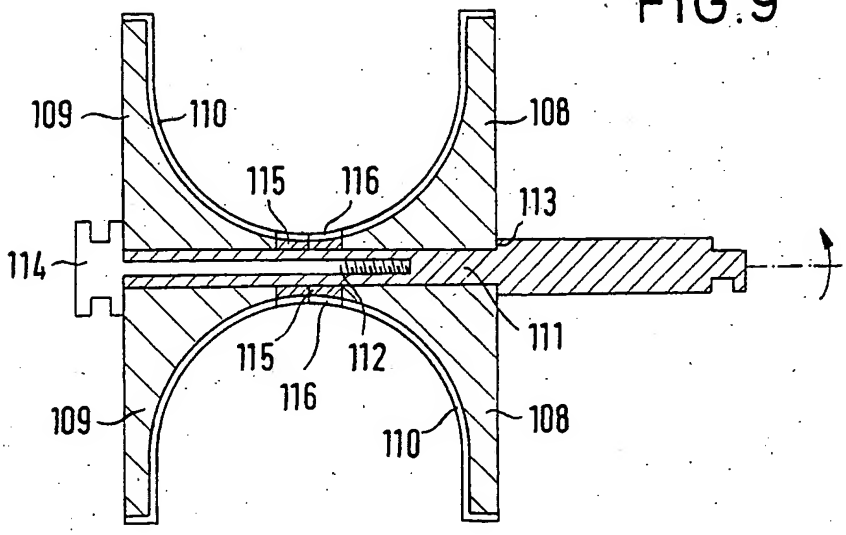
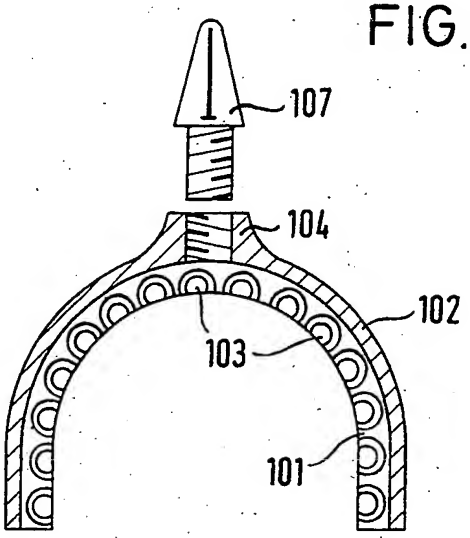

109
110
108
115
116
113
114
111
115
112
116
109
110
108

FIG.8b



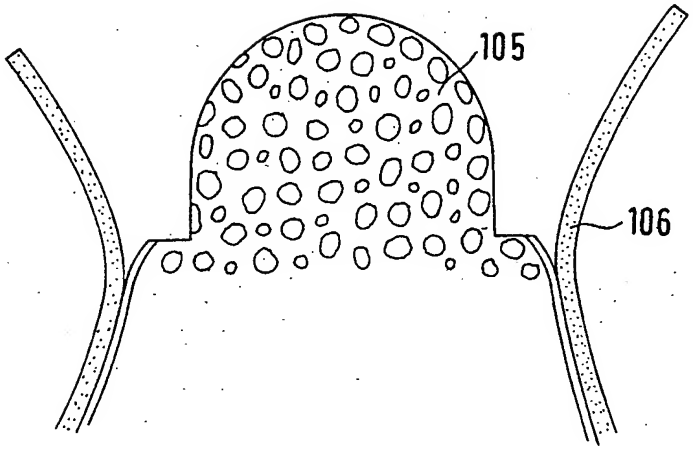


FIG.8a

SPECIFICATION

Dental implant

The invention relates to a dental implant having a root of metal which is compatible with the gingiva for mounting a dental superstructure such as a crown, a mounting element for bridges or the like, wherein the root is connected at least on the side which is in contact with the jawbone to a biostable polymer matrix which is compatible with human tissue and contains reabsorbable bioreactive sintered calcium phosphates.

Implants as known and generally used up to now comprise an anchoring portion made from metal, are constructed in the form of a plate, needle, screw or the like and rely upon a purely mechanical interlocking with the bone in order to anchor the artitificial tooth to the bone. It has already been recognised that various requirements concerning materials must be fulfilled at the same time in order to achieve a lasting, stable implantation. The materials used must be compatible with the bone and the shape of the implants and the mechanical properties of the materials must ensure a physiologically correct load and force pattern since otherwise the bone reacts by rejecting and finally loosening the implant.

The shape of the implant and the instruments necessary for implanting it must permit simple implantation appropriate to the circumstances. In all cases the implant must have a direct, lasting bony connection to the jaw and shoud not be separated from the bone by a layer of connective tissue.

In this connection bioreactive materials have become known recently which enable the bone to grow together with the surface of the material from which the anchoring portion is made without the formation of connective tissue. Examples of such materials are calcium phosphates of a certain composition, wherein the bone grows directly together with the material without the formation of connective tissue (Köster, "Experimenteller Knochenersatz durch resorbierbare Calciumphosphatkeramik" ("Experimental bone substitute using reabsorbable calcium phosphate ceramic") Langenbecks Archiv für Chirurgie 341, 77–86 (1976)). These calcium phosphates can be broken down in the biological environment, i.e. they are absorbed by the cells taking part in the changes to the bone and thus filfil the basic biochemical requirement. However, they cannot be used as the sole constituent in an artificial tooth implanted for a long period of time because the material from which the anchoring portion is made does not remain adequately anchored in the bone.

In order to provide a lasting anchoring of implants subject to high load, in which a truly lasting connection between the artificial tooth and the tissue is formed, it is known (German Offenlegungsschrift No. 2620907) to make the anchoring for the artificial tooth as a coated shaft made from a plastics material which is mechanically and chemically stable in the environment of the mouth and to embed ceramic calcium phosphates in particulate form, with a specific particle size, in the plastics material in such a way that due to reabsorption of the ceramic constituent a thoroughly porous structure of plastics material is produced on the inner surfaces of the pores on which a bioreactive residue of ceramic remains.

The tooth implants known hitherto are predominantly produced in the form of pegs inserted into corresponding drilled holes in the jawbone. In order to accommodate the peg implants the holes must be relatively deep, which is only possible if the recipient of the implant has at the site of the implant a bone able to support the necessary load and if the position is such that a root in peg form is possible.

The object of the invention is to provide a dental implant which is simple to produce and which permits a better and stable growing together with the jawbone without the formation of connective tissue (without rejection of the implant by the natural bone) wherein optionally more than one dental superstructure can be mounted on the implant.

In accordance with the present invention a dental implant has a root in the form of a curved plate of a metal compatible with the gingiva, the plate having a connecting portion for mounting a dental superstructure, at least the surface of the plate which is to contact the jawbone carrying a layer of a biostable polymeric plastics material containing finely dispersed reabsorbable bioreactive sintered calcium phosphate. Preferably the plate is curved in section in one plane but is straight in section in another plane. This enables implants to be used whose shapes correspond to that of the jawbone in any particular case.

In one embodiment of the invention the implant is of saddle shape adapted to straddle the ridge of a jawbone after suitable milling, and carries the connecting portion on its upper surface. In a further embodiment the metal plate is in the form of a tube of which one end, referred to as the upper end, is closed and carries the connecting portion.

In a preferred embodiment of the invention the metal plate is provided with a plurality of holes into which the jawbone may grow. Preferably the holes are filled with reabsorbable sintered calcium phosphate, which may be in the form of preform d tablets introduced into the holes. It is also preferred that the metal plate carries the layer of plastics material with the calcium phosphate on all of its surfaces with the exception of that of the connecting portion.

Thus use of a dental implant in accordance with the invention enables the bone to grow on to the metal plate on both sides and to grow into the holes, reabsorbing the calcium phosphate therein, and thus to anchor the implant in the jawbone without the formation of connective tissue. The biostable polymer matrix provides an anchoring compatible with human tissue for all the areas of the root coming into contact with the bone, whereby the bone tissue reabsorbs only a part of the calcium phosphate in the plastics layer and the remaining calcium phosphate which has not been reabsorbed forms a connection with the bone without connective tissue. Thus there are no special requirements for the production of the layer from the biostable plastics material and reabsorbable calcium phosphates particularly as regards the shape of the particles of calcium phosphate, since a particularly large surface is created for stable growing in of the newly formed bone tissue by reabsorption of the calcium phosphate and the mechanically stable connection between the implant and the bone is formed substantially by the bone tissue growing through the holes as it reabsorbs the calcium phosphate.

By constructing the core as a saddle-shaped metal plate provided with holes it is possible for the bone tissue to grow through the holes from the inside to the outside towards the periosteum which is removed before the implant is inserted and then replaced from the outside after the implant has been fitted onto the bone. An intimate connection is formed and the coating which surrounds the core on all sides provides an environment compatible with human tissue in which the periosteum is able to grow.

If the core is constructed as a tubular metal plate provided with holes, the calcium phosphate present in the holes is reabsorbed and the bone grows together with the inner peg of bone which is left after a tubular hole has been milled out of the bone for the insertion of the tubular implant. If the bone tissue is not such as will allow such a peg of bone to be left, then not only the holes in the implant but also the whole interior of the tubular core can be filled with reabsorbable calcium phosphate.

In a preferred embodiment the metal plate forming the core is made from titanium and the plastics layer from approximately 20% to 30% polymethylmethacrylate (PMMA) and approximately 70% to 80% sintered pulverised and finely dispersed tricalcium phosphate. Since, as has been said, there are no special requirements for the production of the layer, as is the case with the polymer matrices known up to now, as regards size and distribution of the calcium phosphate particles, the layer can be easily applied to the metal plate forming the root by immersion, spraying or painting on or the like. The surface of the metal plate may first be thoroughly cleaned by sandblasting or the like and provided with an adhesive.

The number and size of the holes can be varied as required depending upon the mechanical stability to be achieved and the quality of the bone tissue present. Also, in addition to the saddle and tubular shapes already referred to for the implant, the metal plate may have other convenient shapes which permit growing in on both sides and growing of the bone tissue through the holes.

In accordance with a further aspect of the present invention a milling device for shaping a jaw bone to receive a dental implant which is curved in section in one plane but straight in section in another plane comprises two discs whose edge affords a concave cutting surface, the discs being mounted in opposition on a common shaft coincident with the axes of the discs and affording together a concave cutting surface.

Further features and details of the invention will be apparent from the following description and certain specific embodiments which is given by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic perspective view of a saddle-shaped implant;

Figure 2 is a sectional view of the implant of Fig. 1;

Figure 3 is a diagrammatic perspective view of a tubular implant;

Figure 4 is a longitudinal sectional view of the implant of Fig. 3;

Figure 5 is a sectional view of an enlarged scale of an inserted saddle-shaped implant before reabsorption of the calcium phosphate;

Figure 6 is a diagrammatic sectional view corresponding to Fig. 5 after reabsorption of the calcium phosphate;

Figure 7 is a diagrammatic perspective view of a further embodiment of a saddle-shaped implant;

Figure 8a is a section of the bone milled for the implantation;

Figure 8b is a cross-section of the implant of Fig. 7; and

Figure 9 is a cross-section of a milling device according to the invention for producing a mounting for saddle-shaped implants.

The implant shown in Figs. 1 and 2 is saddle-shaped and consists of a root comprising a plate 1 made from a metal compatible with human tissue, such as titanium, and provided with holes 2. The upper side of the metal plate 1 is provided with a internally threaded head which serves as a connecting portion 3 to receive connecting elements (not shown) of dental superstructures, such as crowns, bridges or the like. The metal plate 1 is covered on substantially all surfaces, including the edges of the holes 2, with a coating 4 of biostable polymeric plastics material containing embedded reabsorbable calcium phos-

phates, only the outer surface 5 of the threaded head forming the conn cting portion 3 being free from the coating 4 in order to permit the gingiva (gum skin) to grow close to it (cf. Figs. 5 and 6). The holes 2 are filled with reabsorbable sintered tricalcium phosphate 6. For the sake of clarity the calcium phosphate ceramic 6 is only shown on the right of Fig. 2. This calcium phosphate can be prepared in tablet form and introduced into the holes 2.

In the further embodiment shown in Figs. 3 and 4 the metal plate 11 forming the root is constructed in tubular form with its lower end open, the upper end being closed and having a threaded head forming a connecting portion 13 for mounting a superstructure (not shown). The holes in the metal plate 11 are designated by the reference numeral 12, the calcium phosphate which is optionally prepared in advance in tablet form and introduced into these holes is designated by 16 and only shown in two places in Fig. 4. The coating covering the metal plate 11 on all surfaces is designated by 14, the free, polished, tissue compatible surface of the connecting portion 13 onto which the gingiva may grow is designated 15.

In the modified saddle-shaped implant shown in Figs. 5 and 6, parts of the implant corresponding to the embodiment of Fig. 1 and 2 are designated by the same reference numerals and will not be described again. The jawbone is designated by 7, the periosteum (bone skin) by 8 and the gingiva (gum skin) by 9. For the implantation the gingiva 9 is drawn back and the periosteum 8 is also drawn back and carefully removed. After the jawbone 7 has been prepared by milling, the implant is inserted and the periosteum 8 and the gingiva 9 are replaced. This is illustrated in Figure 5. Both the bone 7 and the periosteum 8 only touch surfaces of the coating 4 which are compatible with human tissue, at least partially reabsorbable and permit growing on of the bone without the formation of connective tissue, or the calcium phosphate ceramic 6 in the holes 2. After reabsorption of the calcium phosphates 6 and the growing through of the newly formed bone tissue, the situation is as shown in Fig. 6. An intimate connection is made between the newly formed bone tissue 7 in the holes 2 and the periosteum 8. The drawing does not show the partial reabsorption of the calcium phosphates in the coating 4 and the growing in of the bone tissue into the coating 4 without the formation of connective tissue.

In the embodiment shown in Fig. 7 the saddleshaped implant comprises an inner coating 101 and an outer metal plate 102. The inner coating 101 consists substantially of a polymer matrix with calcium phosphate particles 103 embedded in it. One or more connecting portions 104 for mounting the dental superstructure (not shown) can be mounted on the outer metal plate 102.

Fig. 8 shows that the jawbone 105 is shaped with the aid of a milling d vice according to the invention to correspond to the inner surface of the implant. Before this milling can be carried out the gingiva-periosteum 106 must be prepared and drawn away from the jawbone 105 as illustrated in Fig. 8*a*. The upper portion of the implant is provided with a connecting portion 104 which in the form shown in Fig. 8*b* is of curved shape. This has an internally screw threaded bore for fixing the dental superstructure (not shown), such as a bridge, artificial tooth or the like. The screw 107 may be provided as a carrier for the superstructure. The metal plate 102 preferably has a roughened surface. To improve the connection of the gingiva 106 to the implant, the implant can have holes passing through it through which the bone can grow as far as the upper surface of the implant.

The plastics layer on one or all surfaces of the metal plates comprises a layer of biostable plastics material containing finely dispersed calcium phosphate which is preferably in the form of spherical or part spherical particles of reabsorbable tricalcium phosphate ($3CaO.1P_2O_5$). These particles, whose diameter is between 0.2 and 1.2 mm, are covered with a thin layer of substantially non-reabsorbable sintered tetracalcium phosphate ($4CaO.1P_2O_5$) on the side of the particles remote from the outer surface of the plastics layer. This is achieved by embedding the particles in the surface region of the biostable polymer, and then mechanically treating the surface so that about one third of the diameter of the spheres is cut away. When in position in a jawbone the exposed tricalcium phosphate is relatively rapidly reabsorbed and simultaneously replaced by newly formed bone. The tetracalcium phosphate layer reacts in a similarly positive manner to the bone, but is not reabsorbed. As a result the reabsorption process gradually comes to a halt at which point the root is firmly anchored in the jawbone by virtue of the newly formed bone in in the part spherical recesses defined by the layers of tetracalcium phosphate.

The polymer matrix in which the spherical particles are embedded consists of a biostable polymerisate which is compatible with human tissue, e.g. polymethylmethacrylate and copolymers, polypropylene, polyethylene, polyphenylene oxide or preferably polysulphone or the like.

Fig. 9 shows a milling device according to the invention which enables appropriate preparation of the jawbone 105 to be effected. This is a double parabolic internal thread milling device. The device consists substantially of two round discs 108 and 109 which carry a concave cutting surface 110 on th ir outer edge. By mounting the milling disc 108

and 109 in mirror-image on a common shaft 111 which coincides with the axis of rotation, a parabolically shaped cutting surface is formed. This shape of the cutting surface corresponds to the inner contact surface of a saddle-shaped implant. The milling cutters 110 are located on the inside of the parabolic surfaces. A fixing screw 112 is screwed onto the shaft pin 111. Stops 113 provided on the side of the shaft 111 connected to the drive means (on the right hand side of Fig. 9) make it possible to set up the milling device satisfactorily so that it remains correctly aligned. The screw connection 112 serves at the same time as a receptacle 114 for a guide tool. At the other end of the shaft 111 the milling device is connected to a rotary drive means (not shown). This construction makes it possible to guide the milling from both sides. The distance between the two milling discs 108 and 109 can be varied by means of ring inserts 115 which also have cutting surfaces 116 on their outer edges. This makes it possible to extend the milling cutter and thus adapt the tool to any individual case.

CLAIMS

1. A dental implant having a root in the form of a curved plate of a metal compatible with the gingiva, the plate having a connecting portion for mounting a dental superstructure, at least the surface of the plate which is to contact the jawbone carrying a layer of a biostable polymeric plastics material containing finely dispersed reabsorbable bioreactive sintered calcium phosphate.

2. An implant as claimed in Claim 1, in which the metal plate is curved in section in one plane but is straight in section in another plane.

3. An implant as claimed in Claim 1 or Claim 2 in which the metal plate is of saddle shape adapted to straddle the ridge of a jawbone after suitable milling, and carries the connecting portion on its upper surface.

4. An implant as claimed in Claim 1 or Claim 2 in which the metal plate is in the form of a tube of which one end, referred to as the upper end, is closed and carries the connecting portion.

5. An implant as claimed in Claim 4, in which the metal plate is provided with a plurality of holes into which the jawbone may grow.

6. An implant as claimed in Claim 5 in which the holes are filled with reabsorbable sintered calcium phosphate.

7. An implant as claimed in any one of the preceding Claims in which th metal plate carries the lay r of plastics material with calcium phosphate on all of its surfaces with the exception of that of the connecting portion.

8. An implant as claimed in any one of the preceding Claims in which the calcium phosphate in the biostable plastics material comprises tricalcium phosphate in the form of substantially spherical or part spherical particles, the particles being covered with a layer of substantially non-reabsorbable sintered tetracalcium phosphate on the surface remote from the outer surface of the implant.

9. An implant as claimed in Claim 8 in which the particles of tricalcium phosphate are disposed only in the outer surface region of the biostable polymeric plastics material.

10. An implant as claimed in any one of the preceding Claims in which the metal plate is made of titanium and the layer of plastics material with calcium phosphate comprises about 20% to 30% polymethylmethacrylate and about 70% to 80% sintered and pulverised tricalcium phosphate.

11. An implant as claimed in any of the preceding Claims in which the surface of the plate is cleaned by sandblasting and provided with an adhesive.

12. An implant as claimed in Claim 6 or any subsequent Claim when dependent on Claim 6 in which the calcium phosphate in the holes is in the form of preformed tablets introduced into the holes.

13. A dental implant substantially as described herein with reference to Figs. 1, 2, 5 and 6, Figs. 3 and 4 or Figs. 7 and 8 of the accompanying drawings.

14. A milling device for shaping a jawbone to receive a dental implant which is curved in section in one plane but straight in section in another plane, comprising two discs whose edge affords a concave cutting surface, the discs being mounted in opposition on a common shaft coincident with the axes of the discs and affording together a concave cutting surface.

15. A device as claimed in Claim 14 in which the distance between the two discs is variable, the device including one or more ring inserts between the two discs having cutting surfaces on their outer edges.

16. A device as claimed in Claim 14 or Claim 15 including means for receiving a guide tool carried by the shaft remote from the end adapted for connection to a drive means so that milling can be guided at both ends of the shaft.

17. A milling device substantially as herein described with reference to Fig. 9 of the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1979.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.